6—CONSTITUTION OF A COPPER TELLURIDE FROM THE KALGURLI G.M., KALGOORLIE.

By

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The material, which was received for examination from Dr. F. L. Stillwell, of the Council for Scientific and Industrial Research, was in the form of a fine black powder. The locality given was the No. 4 level, Kalgurli Mine, a short distance below the oxidised zone. Mr. Paton, Metallurgist of the South Kalgurli Mine, who, I understand, first collected the specimen, does not think that it has been found in any other mine in the district, and only over a very limited area there.

The composition of the powder is shown in the following analysis:—

	%
Gold	23.16
Silver	2.77
Copper	32.22
Tellurium	42.06
Iron	0.13
Lead	trace
	100.34

The object of the investigation was to discover, if possible, the relationship between the elements present and whether the percentage composition corresponded to a simple molecular ratio or to a mixture of elements and chemical compounds. To this end experimental work was conducted which led to the discovery that almost all the copper and tellurium present in the sample could be dissolved out with a solution of ammonia, the other constituents remaining unattacked.

Based on this fact the following method of analysis was adopted:—

A weighed portion of the powder was placed in a small silica beaker and treated with warm 5 E ammonia. The solution was decanted off at intervals and repeated applications of fresh solvent made until no further solution of copper took place. The residue, consisting mainly of gold, was caught in a tared sintered glass filter crucible, washed, dried at 105° C., and weighed. Copper and tellurium were determined in the ammoniacal filtrate.

The residue, insoluble in ammonia, was leached with a weak (0.2%) solution of potassium cyanide until the free gold was removed, and weight of crucible and residue after drying at 105° C. remained constant.

The residue, insoluble in potassium cyanide, was treated on the crucible with warm 10 E nitric acid until no further action took place. This decomposed any remaining telluride mineral unattacked by the previous treatment.

Copper and tellurium were determined in the nitric acid solution.

The final residue in crucible, returned as insoluble in nitric acid, was gold apparently resulting from the decomposition of a telluride of gold and copper.

The figures obtained by this method of treatment are shown hereunder:—

		%	Mols.
Soluble in 5 E ammonia—			
	Copper	31.80	500
	Tellurium	39.26	308
Soluble in 10.2% potassium cyanide—			
	Gold	22.26	113
	Silver	2.77	26
	Copper	0.02	
Soluble in 10 E nitric acid—			
	Copper	0.40	6
	Tellurium	2.80	22
	Iron	0.13	2
Insoluble in 10 E nitric acid—			
	Gold	0.90	5
		100.34	

These results give the ratio of copper to tellurium in the ammonia soluble portion as very nearly 5 to 3. By applying the method generally used in the calculation of mineral formulae the composition of the powder would appear to be as follows:—

	%
Cu_5Te_3, soluble in ammonia	71.06
Au, Ag, Cu, soluble in potassium cyanide ..	25.05
(Au, Cu) Te_2 decomposed by nitric acid ..	4.10
Fe	.13
	100.34

It is suggested, therefore, that the powder consists of a mixture of telluride of copper, native gold, and telluride of gold and copper. Dr. Stillwell, who kindly read the first draft of this paper, suggests that Sylvanite is an important constituent of the mixture and should be found in the residue after treatment with ammonia and cyanide. Further, that the

residual copper is present as occluded granules of weissite. The analytical data, however, are not easily interpreted in this way, unless we assume that sylvanite is partly attacked by KCN with solution of gold and silver and separation of elemental tellurium. The formula found for the copper telluride Cu_5Te_3 agrees with that of a new mineral Weissite,* described by Mr. Wm. P. Crawford. This mineral occurs in the Good Hope and Mammoth Chimney Mine at Vulcan, Gunnison County, Colorado.

Rickardite, a telluride of copper, the formula of which is given as Cu_4Te_3, has also previously been recorded from the Good Hope Mine.

Analyses of the original American Weissite gave—

	1.	2.
	%	%
Copper	45.72	45.97
Tellurium	54.05	53.89

The ratio Cu : Te is very nearly 5 : 3.

It is not made quite clear in the paper referred to whether these analyses were made on separate samples or were simply duplicate determinations on the one specimen. If separate samples were taken the close agreement of the figures obtained would certainly indicate the existence of one definite compound, Cu_5Te_3, and not of a mixture of copper tellurides of varying composition.

It may be of interest here to study the composition of the following artificially prepared selenides and tellurides of copper and of the known minerals of these species.

Selenides of Copper†—

Artificial	Cu_2Se	Cu_3Se_2	CuSe
Mineral	Berzelianite	Umangite	Not known.

Tellurides of Copper—

Artificial ..	Cu_2Te	...	...	CuTe
Mineral ..	Not known	Weissite (Cu_5Te_3)	Rickardite (Cu_4Te_3)	Not known.

It will be noted that the two compounds known as minerals in the telluride group, Weissite and Rickardite, have not as yet been prepared artificially.

The possible occurrence, then, of a mixture of the two known artificial tellurides, Cu_2Te and CuTe, must be taken into account in the interpretation of any analytical figures obtained. Although the presence of the mineral Cu_5Te_3 is indicated in the material received from Dr. Stillwell this could not be definitely established as no metallographic data could be obtained owing to the nature of the sample submitted, a very fine powder. There still remains the possibility of a mixture of copper tellurides being present.

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* American Journal of Science, Vol. xiii., April, 1927.

† Doelter, Vol. iv., Part I.

A specimen of copper telluride was obtained from the Kalgurli Mine in 1921 by Dr. E. S. Simpson, Government Mineralogist and Analyst, W.A. The specimen is of a bronze colour, slightly tarnished, and shows gold freely in coarse masses and in finely disseminated flakes and grains. Gold can also be microscopically seen filling minute fissures in the surface of the mineral. The unbroken specimen shows no definite crystalline form, but bright individual cleavage faces with distinct outlines can be seen on the fracture surfaces.

Although no analysis has been made of the specimen, a qualitative examination showed the presence of abundant copper and tellurium, and it would appear to be of similar composition to Dr. Stillwell's sample, of which the analysis was made.